CARDIOLOGY NOTEBOOK

For preliminary instruction in medical curricula

COLUMBIA UNIVERSITY
COLLEGE OF
PHYSICIANS AND SURGEONS



GRUNE & STRATTON NEW YORK AND LONDON

Sections

NOTE. A detailed list of contents is given on the first page of each of the four sections.

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Foreword

DURING THE PERIOD OF TRANSITION from the basic sciences to clinical medicine the medical student needs some immediate orientation in many aspects of clinical medicine at a time when he lacks an adequate grasp of any single subject.

This Notebook is designed to make readily available to him in the simplest form a few basic examples of the method and language of cardiology and thereby to make easier and clearer the initial clinical instruction in this subject The subject matter has been divided into four sections (1) cardiac fluoroscopy and x ray (2) electrocardiography (3) hemodynamics (4) nomenclature for cardiac diagnosis.

The idea of the Notebook originated in the course of discussions in a Cardiovascular Teaching Committee which had been formed to develop improvements in the teaching of cardiology at the College of Physicians and Surgeons, under a grant from the National Heart Institute Much additional assistance has been given by the Institute as the preparation of the Notebook has progressed The editors take pleasure in acknowledging this and wish particularly to thank Dr J Franklin Yeager Chief of the Grants and Training Branch of the National Heart Institute for his interest, encouragement, and helpful counsel during the course of the work.

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April 1955

Acknowledgments

THE ILLUSTRATIONS FOR THIS NOTEBOOK are based except where indicated upon studies performed in the Departments of Medicine and Radiology of the Presbyterian Hospital, and the Cardiopulmonary Laboratory of Bellevue Hospital. The heart models in Section I are those of the American Heart Association The additional illustrations were derived from the following sources

Figures 1 3 5 (and accompanying text) Modified after Grossman N Compendium of Cardiac Roentgenology Teaching and Research Council Michael Reese Hospital, Chicago Illinois, 1945

Figure 13. Dotter C T and Steinberg I. Angiocardiographic interpretation *Radiology 53 513 1949*

Figure 14. Redrawn after Taussig H. Congenital Malformations of the Heart Commonwealth Fund New York 1947

Figure 15B Modified after Coblentz B. Harvey R. M Ferrer M. I Cournand A. and Richards D W Jr The relationship between electrical and mechanical event in the cardiac cycle of man Brit. Heart J., 11 1 1949.

Figure 16 1. Hoff H. E. in Fulton, J F A Textbook of Physiology W B. Saunders Co. Philadelphia 1949

Figure 16C and 16D Braunwald, E. Moscovitz, H L. Amram, S. S. Lasser R. P Sapin S. O. Himmelstein A. Ravitch M. M. and Gordon A. J The hemodynamics of the left sid of the heart a studied by simultaneous left atrial left ventricular and aortic pressures particular reference to mitral stenosis. Circulation *in press.*

Figure 17 The cardiac catheterization group Mt. Sinai Hospital New York.

Figure 18 Grishman A. and Donoso E. Mt. Sinai Hospital, New York.

The nomenclature for cardiac diagnosis is based largely on Nomenclature and Criteria for Diagnosi of Diseases of th Heart and Blood Vessels 5th Edition New York Heart Association Inc. New York, 1953.

Introduction

The basis of all cardiac diagnosis and treatment is an adequate history and physical examination. The great majority of clinical problems can be handled by these two procedures alone.

These methods can only be gained at the bedside and no plethora of laboratory examinations can replace them. Indeed laboratory studies lack direction and are often of little avail in the absence of adequate prior clinical evaluation.

The subsequent pages are designed to supplement rather than substitute for such clinical evaluation.

Cardiac Fluoroscopy and X Ray

SECTION 1

IT IS IMPORTANT FOR THE STUDENT to be instructed in the technique of fluoroscopic examination This instruction should include proper handling of the apparatus so as to minimize radiation hazard to himself and the patient It is worthy of emphasis that adequate visual accommodation prior to fluoroscopy will not only improve the ability to discern fine detail *such as intracardiac calcifications but will also shorten the time required* for complete fluoroscopic examination

As in the physical examination information gained from extra-cardiac regions may direct the examination to the correct cardiac disorder It is therefore essential that the neck lung diaphragms and thoracic cage be evaluated prior to focussing on the heart

It is no longer adequate in most instances to describe the heart merely as enlarged It is usually possible by taking advantage of the proximity of the cardiac chambers to the esophagus trachea and spine and by examination of the patient in various positions to delineate the size and shape of individual cardiac chambers and vessels

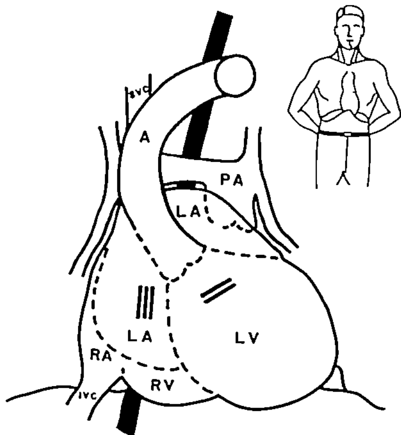
The standard positions for cardiac fluoroscopy are

1 Postero-Anterior PA patient facing the screen

2 Left Anterior Oblique LAO patient s left shoulder turned toward the screen with patient facing the screen

3 Right Anterior Oblique RAO patient s right shoulder turned toward the screen with patient facing the screen

These positions are illustrated in the figures on pages 8 12 10 The degree of obliquity necessary for adequate visualization varies with the habitus of the patient but is more marked in the LAO than in the RAO


SVC
A
PA
LA
LA
LV
RA
RV
IVC

THE POSTERO-ANTERIOR (PA) VIEW

FIGURE 1—AT LEFT

The outline of the cardiac shadow can be divided into segments formed by individual chambers or great vessels

On the patient's right the upper curve of the RIGHT ATRIUM is separated from the ASCENDING AORTA by an indentation. The difference between atrial and aortic pulsations further delineates the position of each structure on the contour of the right border of the heart

On the left three curves are noted from below upwards the lateral curve of the LEFT VENTRICLE, the PULMONARY ARTERY and the ARCH OF THE AORTA Occasionally the tip of the LEFT AURICULAR APPENDAGE may be identified above the left ventricle usually at about the third interspace

The upper end of the interventricular septum is identified by the "POINT OF OPPOSITE PULSATION" between the left ventricle and the pulmonary artery The dome of the left side of the diaphragm usually obscures the lower border of the heart and the lower end of the interventricular septum

All four intracardiac valves have been represented schematically on the anterior surface of the heart The frontal projection of the left ventricle left atrium and aorta have been emphasized in this drawing to illustrate the relative positions of the aortic and mitral valves The AORTIC and PULMONIC VALVES are indicated by dotted lines the MITRAL VALVE by 2 slanting bars the TRICUSPID VALVE by 3 vertical bars

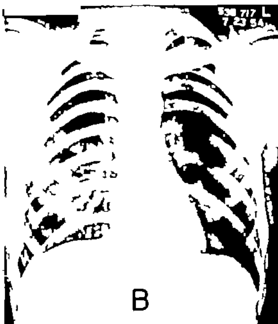
Not only may alterations in the total configuration of the heart be identified e.g as in pericardial effusion but also abnormal pulsations of individual chambers or vessels may be visualized Thus enlargement of the pulmonary artery an aortic or left ventricular aneurysm and "HILAR DANCE" are some of the conditions that may be identified in the PA position Enlargement of the RIGHT VENTRICLE is difficult to detect in this position since this chamber does not normally appear at either of the cardiac borders.

Displacement and deformity of adjacent structures—spine trachea or barium-filled esophagus—may be of diagnostic aid

Continued on next page



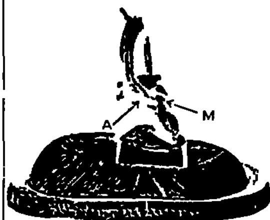
A



B



C



D

FIGURE 2—AT LEFT

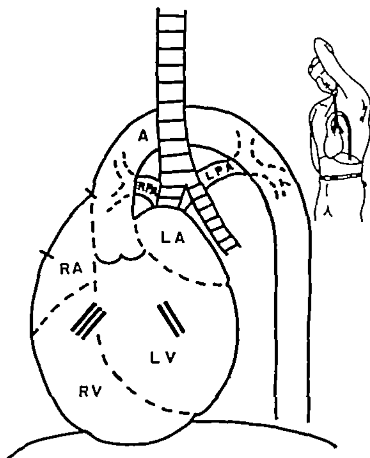
A. Model, normal heart asthenic subject

B Normal male A vertical heart in a thin subject with low diaphragms

C Model normal heart, short obese subject

D Model plastic cast of interior of left ventricle left atrium and aorta illustrating the relative positions of the mitral valve (M) and aortic valve (A)

NOTES


A
RPA
LPA
LA
RA
LV
RV

THE LEFT ANTERIOR OBLIQUE (LAO) VIEW

FIGURE 3—AT LEFT

This position makes available anatomic information not readily gained in any other position. Enlargement of the LEFT VENTRICLE is established by measurement of the contour bounded by the atrioventricular and interventricular grooves. An enlarged LEFT ATRIUM may displace the left main bronchus superiorly and encroach upon the AORTIC WINDOW. A coarctation of the aorta may be visible. The size of the RIGHT AURICULAR APPENDAGE is best judged in this view.

The positions of the MITRAL, AORTIC and TRICUSPID VALVES are indicated.

The anterior outline of the heart is formed from below upward by the RIGHT VENTRICLE, the RIGHT AURICULAR APPENDAGE and the ASCENDING AORTA. The course of the AORTA is well seen in this view. The posterior outline of the heart is formed by the LEFT VENTRICLE below and the LEFT ATRIUM above. A shallow groove, the ATRIOVENTRICULAR GROOVE, separates the two. At the junction of the left ventricle with the diaphragm, the INTERVENTRICULAR GROOVE can often be demonstrated following deep inspiration. The border between the two grooves delineates the contour of the LEFT VENTRICLE.

The bifurcation of the TRACHEA lies within the shadow of the AORTIC ARCH.

Continued on next page

NOTES


A


B


C


D

LEFT ANTERIOR OBLIQUE (LAO) VIEW continued

FIGURE 4—AT LEFT

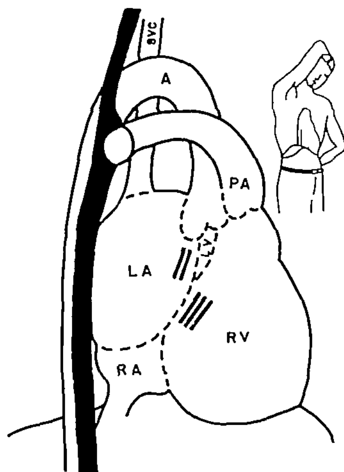
A. Model normal heart asthenic subject

B Normal male Extra-cardiac calcifications are superimposed upon the cardiac silhouette

C Model left ventricular enlargement due to systemic hypertension

D Patient with systemic hypertension left ventricular enlargement

NOTES


SVC
A
PA
LA
LV
RV
RA

THE RIGHT ANTERIOR OBLIQUE (RAO) VIEW

FIGURE 5—AT LEFT

This view has particular value in detecting enlargements of the RIGHT VENTRICLE anteriorly and LEFT ATRIUM posteriorly. Examination for the LEFT ATRIUM in this position includes observation of indentation of the barium filled esophagus after establishing in the PA view that the esophagus is pursuing its normal course in the thorax.

The abnormal course of certain vascular structures may be identified by distortion of the barium filled esophagus.

In the normal heart the anterior (retro-sternal) border is formed by the anterior border of the RIGHT VENTRICLE. The posterior contour of the heart is formed by the LEFT ATRIUM above and the RIGHT ATRIUM and INFERIOR VENA CAVA below. The ESOPHAGUS usually lies between the anterior border of the aorta (behind) and the posterior border of the heart. When filled with thick barium the continuity of its anterior contour is broken by normal indentations of the aorta, the right bronchus and the constriction of the diaphragm.

The relative positions of all four of the heart valves are indicated in the drawing at the left.

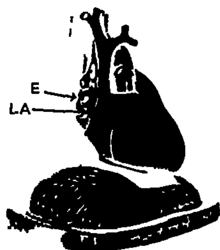
Continued on next page

NOTES



A


B



C


D

RIGHT ANTERIOR OBLIQUE (RAO) VIEW continued

FIGURE 6—AT LEFT

A. Model normal heart, asthenic subject. Esophagus (E) left atrium (LA) and right atrium (RA) are indicated to emphasize their relations in this position

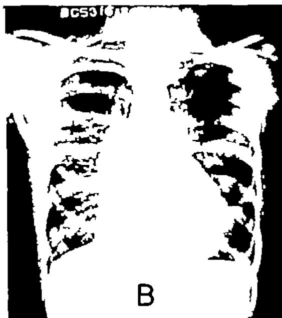
B Normal male

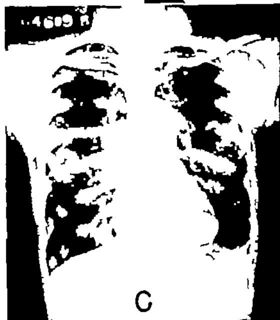
C Model demonstrating displacement of the esophagus (E) posteriorly and to the right by an enlarged left atrium due to mitral stenosis. The right atrium lies anterior and inferior to the left atrium

D Patient with mitral stenosis, illustrating displacement of the barium filled esophagus by the large left atrium

NOTES


A


B


C

RIGHT VENTRICULAR HYPERTROPHY CHRONIC COR PULMONALE

(PA View)

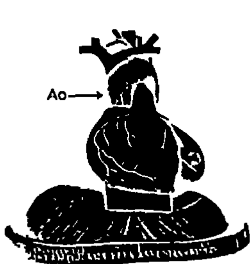
FIGURE 7—AT LEFT

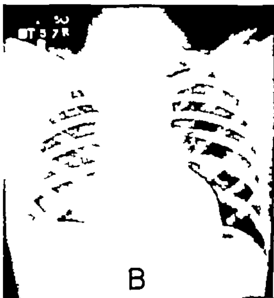
A Model demonstrating prominent pulmonary artery segment and right ventricular hypertrophy

B Patient with chronic cor pulmonale secondary to chronic obstructive pulmonary emphysema right ventricular enlargement severe pulmonary hypertension congestive heart failure normal sinus rhythm Class IV E

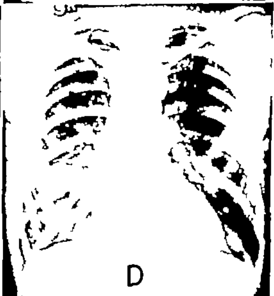
C Same patient as B after intensive treatment for congestive heart failure with bed rest salt restriction antibiotics bronchodilators digitalis and mercurial diuretics chronic cor pulmonale secondary to chronic obstructive emphysema right ventricular enlargement now only minimal pulmonary hypertension normal sinus rhythm Class II C

NOTES


Ao
A


B


C


D

LEFT VENTRICULAR HYPERTROPHY (PA View)

FIGURE 8—AT LEFT

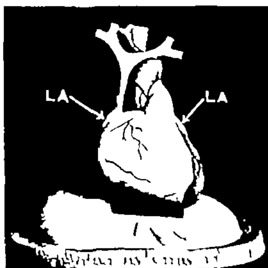
A. Model demonstrating enlargement of the left ventricle and dilatation of the ascending aorta (AO)

B Patient illustrating left ventricular enlargement due to hypertensive cardiovascular disease

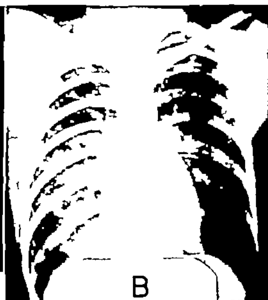
C Patient illustrating left ventricular enlargement and dilatation of the ascending aorta due to arteriosclerotic heart disease

D Patient, illustrating left ventricular enlargement due to aortic insufficiency

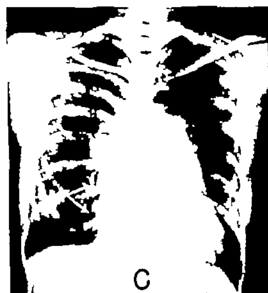
NOTES



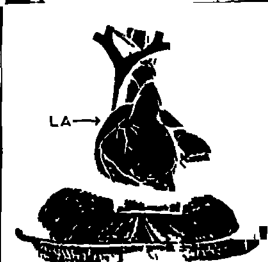
A



B



C



D

MITRAL STENOSIS (PA View)

FIGURE 9—AT LEFT

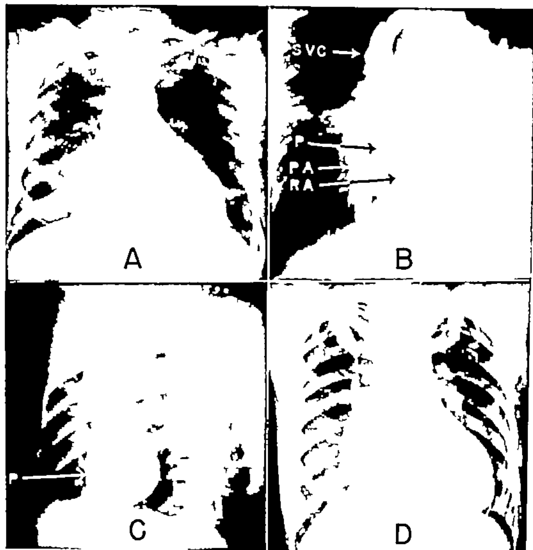
A Model demon trating enlargement of the left atrium (LA) and of the right ventricle in mitral stenosis

B Patient with mitral tenosis The normal concavity in the region of the pulmonary artery is obliterated by the prominent pulmonary artery and the dilated left auricular appendage Intrapulmonary vascular mark ings are prominent

C Patient with mitral stenosis illu trating the double contour on the right border of the heart due to the left and right atria (double arrows) A similar doubl contour is seen in models in A and D

D Model of mitral stenosi and aortic in ufficiency with combined en largement of the left atrium (LA) right ventricle and left ventricle

NOTES


SVC
P
PA
RA
A
B
P
C
D

PERICARDITIS

FIGURE 10—AT LEFT

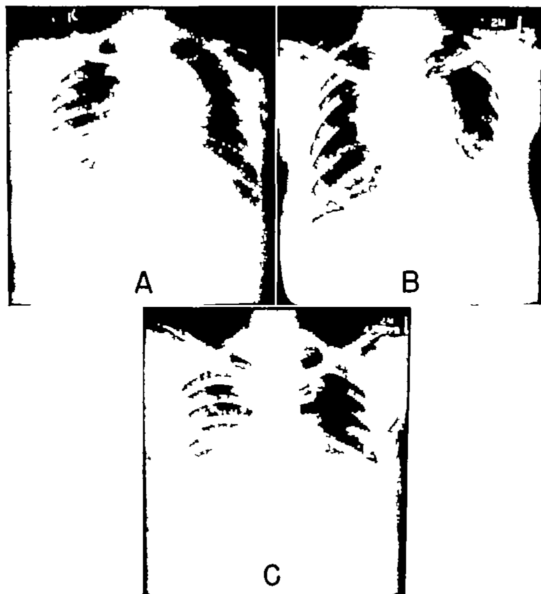
A. Pericarditis with effusion PA view

B Pericarditis with effusion PA angiocardiogram During this exposure dye renders the superior vena cava right atrium (RA) and pulmonary artery (PA) opaque The area between RA and PA is less radiolucent than normal due to the presence of a pericardial sac distended with fluid

C Constrictive pericarditis LAO view with the calcified pericardium (P) demarcating the cardiac chambers

D Generalized cardiac enlargement due to diffuse myocardial disease The cardio-hepatic angles are sharper than in A but distinction from pericarditis with effusion may be difficult in such cases.

NOTES


A
B
C

ANEURYSMS (PA View)

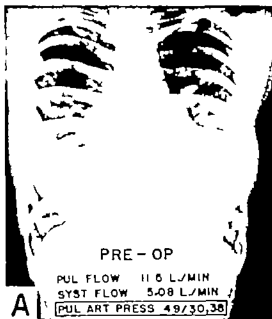
FIGURE 11—AT LEFT

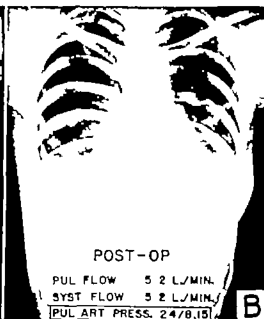
A. *Aneurysm of aortic arch*

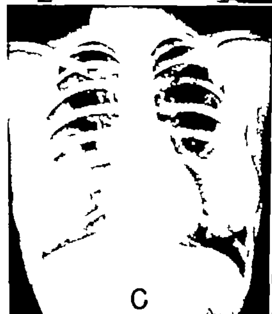
B Aneurysm of ascending aorta, with flecks of calcium in aneurysmal sac

C Aneurysm of left ventricle following myocardial infarction Lung fields are congested

NOTES


PRE - OP
PUL FLOW 11.6 L/MIN
SYST FLOW 5.08 L/MIN
PUL ART PRESS 49/30,38
A


POST-OP
PUL FLOW 5.2 L/MIN.
SYST FLOW 5.2 L/MIN.
PUL ART PRESS. 24/8,15
B


C


D

ACYANOTIC CONGENITAL HEART DISEASE (PA View)

FIGURE 12—AT LEFT

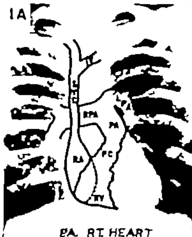
A. Patent ductus arteriosus prior to surgery Pulmonary arterial pressures and flows are indicated

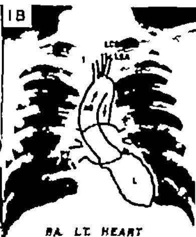
B Same patient as A after ligation of ductus The prominence of the pulmonary arterial segment and pulmonary congestion have decreased

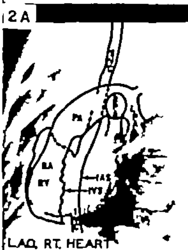
C Inter atrial septal defect of small size Pulmonary arterial segment is prominent

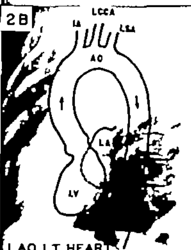
D Inter atrial septal defect of large size The transverse diameter of the heart is increased. The pulmonary artery segment is very prominent pulmonary vascular markings are increased

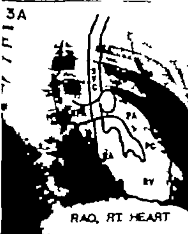
NOTES


1A
RPA
PA
RA
PC
RV
PA. RT. HEART


1B
LCCA
LSA
L
PA. LT. HEART


2A
PA
RA
RV
IAS
IVS
LAO. RT. HEART


2B
LCCA
IA
LSA
AO
LA
LV
LAO LT. HEART


3A
SVC
RPA
PA
PC
RA
RV
RAO. RT. HEART


3B
AO
LA
LV
RAO. LT. HEART

FIGURE 13—AT LEFT

Idealized diagrams of configuration

1A FRONTAL PROJECTION RIGHT HEART

IV Left innominate vein SVC Superior vena cava RA, Right atrium RV Right ventricle PC Pulmonary conu PA, Pulmonary artery LPA, Left pulmonary artery RPA, Right pulmonary artery

1B FRONTAL PROJECTION LEFT HEART

IA Innominat artery LCCA, Left common carotid artery LSA, Left subcla ian artery PV Pulmonary veins LA Left trium LV Left entricle AO Aorta

2A LEFT ANTERIOR OBLIQUE PROJECTION RIGHT HEART

SVC Superior ena ca IVC Inferior vena cava RA, Right atrium RV Right ventricle RAA, Right auricular appendage PA, Pulmonary artery RPA, Right pulmonary artery LPA, Left pulmonary artery IAS Interatrial septum IVS Interventricula septum

2B LEFT ANTERIOR OBLIQUE PROJECTION LEFT HEART

IA Innominat artery LCCA Left common carotid rtery LSA Left subcla ian artery LA Left trium LV Left ventricle AO Aorta

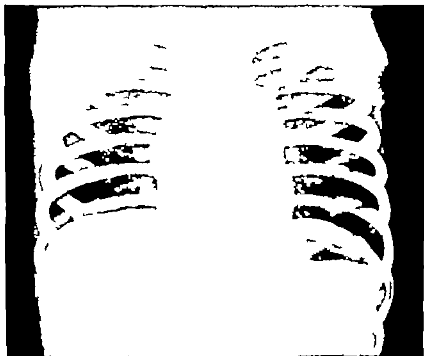
3A RIGHT ANTERIOR OBLIQUE PROJECTION RIGHT HEART

SVC Superior vena cava RA, Right atrium RV Right entricle PC Pulmonary conus PA, Pulmonary artery RPA, Right pulmonary rtery The left pulmonary artery is seen a rounded, double-den t midhilar shadow

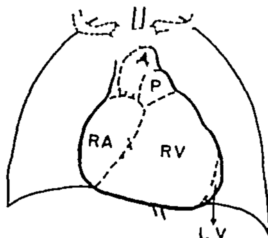
3B RIGHT ANTERIOR OBLIQUE PROJECTION LEFT HEART

LA Left trium LV Left ventricle AO Aorta I this projection, the left trium nd the right trium form the posterior cardiac border

FIGURE 14

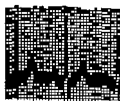


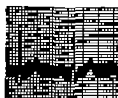
I the normal infant and child, the chest i rounder the diaphragm higher and the chest squatter than in the normal adult.

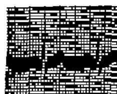


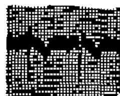
Electrocardiography

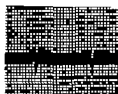
SECTION 2

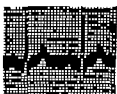

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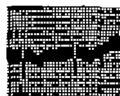

II

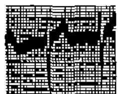

III

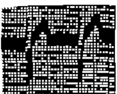

aVR

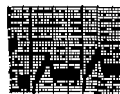

aVL

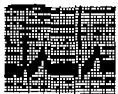

aVF


V1


V2


V3


V4


V5


V6

Normal Electrocardiogram—vertical position

NORMAL SINUS RHYTHM—VERTICAL POSITION

REPORT OF ELECTROCARDIOGRAM

EKG No. *1*

Name ______ Age *[illegible]* Date & Time ______ Chart No. ______

Blood Pressure *120/70* Habitus *Asthenic* Position *Supine* Drugs *None*

Atrial rate *[illegible]* /min P R interval *0 17* sec. Q T interval ______ sec.
Vent. rate *[illegible]* /min QRS duration *0 0* sec. Dev. Elect. Axis *None*

Deviation from Normal:

I		V1	
II		V2	
III		V3	
VR		V4	
VL		V5	
VF		V6	

Interpretation *Normal sinus rhythm No axis deviation*

Normal record Vertical electrocardiographic position

The ventricular complexes of lead VL are similar to those of leads V1 and V2 the ventricular complexes of lead VF are similar to those of lead V5 and V6



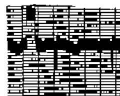
I



II



III



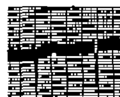
aVR



aVL



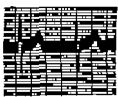
aVF



V1



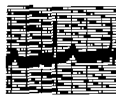
V2



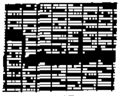
V3



V4



V5



V6

Normal Electrocardiogram—horizontal position

REPORT OF ELECTROCARDIOGRAM

Name ______ Age *45* Date & Time ______ EKG No. ______

Blood Pressure *140/70* Habit *Sthenic* Position *Supine* Chart No. ______ Drugs *None*

Atrial rate *78* /min. P-R interval *0.1* sec. Q-T interval ______ sec.

Vent. rate *78* /min. QRS duration *0.07* sec. Dev. Elect. Axis *Left*

Deviation from Normal

I	—		
II	—	V1	—
III		V2	—
aVR		V3	—
aVL		V4	—
VF		V5	
		V6	

Interpretation *Normal sinus rhythm. Left axis deviation.*

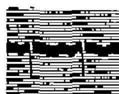
Normal record. Horizontal electrocardiographic position.

The ventricular complexes of lead aVL are similar to those of lead V5 and V6; the ventricular complexes of lead aVF are similar to those of leads V1 and V2.



















Sinus Arrhythmia

REPORT OF ELECTROCARDIOGRAM

Name ________ Age *21* Date & Time ________ EKG No. *4*

Blood Pressure *110/65* Habitus ________ Position *Supine* Chart No. ________

Atrial rate *75* /min. Vent. rate *75* /min. P-R interval *0.18* sec QRS duration *0.05* sec Q-T interval ________ sec Drugs *None*

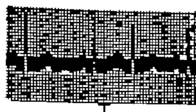
Dev. Elect. Axis *None*

Deviation from Normal:

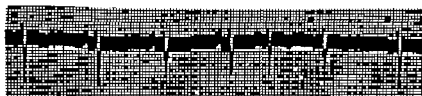
I		V1	
II		V2	
III		V3	
aVR		V4	
aVL		V5	
aVF		V6	

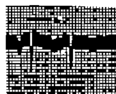
Interpretation *Sinus arrhythmia. No axis deviation*

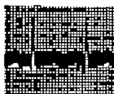
Rather marked sinus arrhythmia is noted but the form of the complexes is otherwise unremarkable

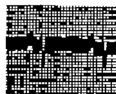


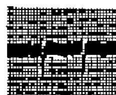


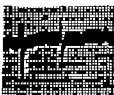


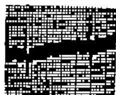












Atrial Premature Contractions

ATRIAL PREMATURE CONTRACTIONS

REPORT OF ELECTROCARDIOGRAM

EKG No. 4

Name ________ Age 30 Date & Time ________ Chart No. ________

Blood Pressure 110/72 Habitus ________ Position Supine Drugs None

Atrial rate 75 /min. P-R interval 0.17 sec. Q-T interval ________ sec.
Vent. rate 75 /min. QRS duration 0.07 sec. Dev. Elect. Axis Left

Deviation from Normal

I		V1	
II		V2	
III		V3	
VR		V4	
VF		V5	
VL		V6	

Interpretation *Normal sinus rhythm, atrial premature contractions. Left axis deviation.*

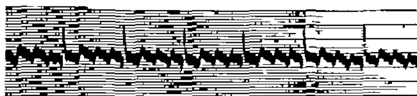
A moderate number of premature atrial beats are noted and are marked with dots. The form of the complexes is otherwise unremarkable.



I



III



II



aVR



aVL



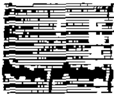
aVF



V1



V3



V5

Atrial Flutter

ATRIAL FLUTTER

REPORT OF ELECTROCARDIOGRAM

EKG No. 4

Name ________ Age 50 Date & Time ________ Chart No. ________

Blood Pressure 100/70 Habitus ________ Position Supine Drugs None

Atrial rate 288 /min. P-R interval ____ sec. Q-T interval ________ sec.
Vent. rate [illegible] /min. QRS duration 0.09 sec. Dev. Elect. Axis None

Deviation from Normal		
	I ________	V1 R' present
	II ________	V2 ________
	III R slurred	V3 ________
	VR ________	V4 ________
	VL ________	V5 ________
	VF ________	V6 ________

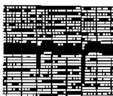
Interpretation *Atrial flutter with 4:1 A-V response. No axis deviation.*

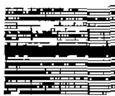
In addition to the arrhythmia, the presence of an R' in V1 suggests incomplete right bundle branch block. T waves are obscured.


I


III


II

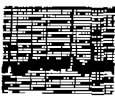

aVR


aVL


aVF


V1


V3


V5

Atrial Fibrillation

REPORT OF ELECTROCARDIOGRAM

EKG No. *4*

Name ________ Age *60* Date & Time ________ Chart No. ________

Blood Pressure *160/70* Habitus ________ Position *Supine* Drugs *None*

Atrial rate *450* /min P R interval ____ sec Q-T interval ________ sec

Vent. rate *70* /min QRS duration *0.05* sec Dev. Elect. Axis *None*

Deviation from Normal:

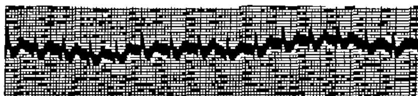
I *T low*	V1
II *ST depressed*	V2
III *T low*	V3 *T diphasic*
VR *T upright*	V4
VL *T low*	V5 *T inverted*
VF *ST depressed, T low*	V6

Interpretation *Atrial fibrillation. No axis deviation*

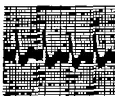
The T waves, although obscure at times, suggest the presence of myocardial disease


I

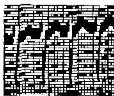

III

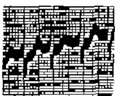

II

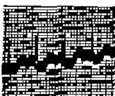

aVR


aVL


aVF


V1


V3


V5

Supraventricular Tachycardia

REPORT OF ELECTROCARDIOGRAM

Name ______ Age 30 Date & Time ______ EKG No. ______

Blood Pressure 125/80 Habitus ______ Position Supine Drugs None Chart No. ______

Atrial rate ______/min P-R interval ______ sec Q-T interval ______ sec

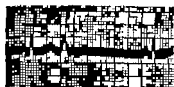
Vent. rate 138/min. QRS duration 0.09 sec Dev. Elect. Axis Left

Deviation from Normal:

I ST depressed	V1
II ST depressed	V2
III	V3 ST depressed
VR ST elevated	V4
aVL ST depressed	V5 ST depressed
VF	V6

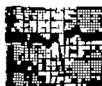
Interpretation: Supraventricular tachycardia. Left axis deviation.

No definite atrial activity can be seen.

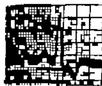


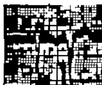
















Ventricular Premature Contractions—coupled with compensatory pause

REPORT OF ELECTROCARDIOGRAM

EKG No. 8

Name ______ Age 48 Date & Time ______ Chart No. ______

Blood Pressure 130/70 Habitus ______ Position Supine Drugs None

Atrial rate 85 /min. P-R interval 0.13 sec Q-T interval ______ sec
Vent. rate 83 /min QRS duration 0.05 sec Dev. Elect. A. None

Deviation from Normal:

I	______	V1	______
II	______	V2	______
III	______	V3	______
VR	______	V4	______
VL	______	V5	______
VF	______	V6	______

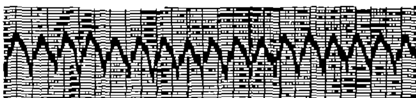
Interpretation *Normal sinus rhythm with coupled premature ventricular contractions. No axis deviation.*
The form of the sinus beats is within normal limits.



I



II



III



CF4

Ventricular Tachycardia

REPORT OF ELECTROCARDIOGRAM

EKG No. 9

Name ______ Age 45 Date & Time ______ Chart No. ______

Blood Pressure 83/60 Habitus ______ Position Supine Drugs None

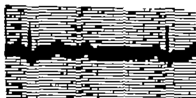
Atrial rate ____ /min. P R interval ____ sec. Q T interval ____ sec.
Vent. rate 187 /min. QRS duration 0.13 sec. Dev. Elect. Axis ______

Deviation from Normal

I		V1	
II		V2	
III		V3	
VR		V4	
VL		V5	
aVF		V6	

Interpretation: *Ventricular tachycardia.*

A rapid regular tachycardia is noted. A widened QRS which greater than 0.13 second in duration suggests pacemaker arising somewhere in the ventricle, or that bundle branch block is present. Comparison with previous records clearly demonstrates that bundle branch block is not present here. Furthermore careful analysis of this record indicates that the P waves are completely dissociated in their rhythm from the QRS complexes, confirming the presence of ventricular tachycardia.



I



III



II



aVR



aVL



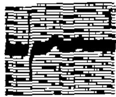
aVF



V1



V3



V5

2 1 A V Block

REPORT OF ELECTROCARDIOGRAM

EKG No. *10*

Name ______ Age *2* Date & Time ______ Chart No. ______

Blood Pressure *150/70* Habitus ______ Position *Supine* Drugs *None*

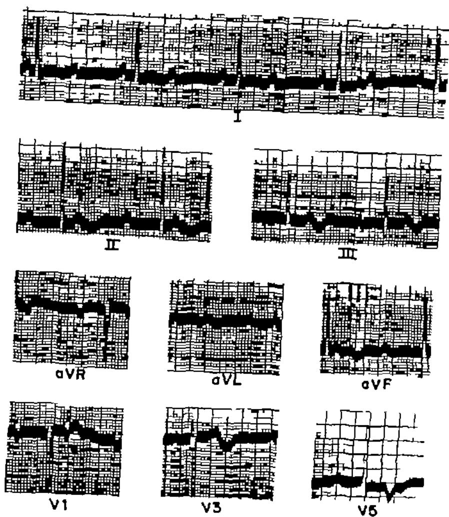
Atrial rate *70* /min P-R interval *0.20* sec. Q-T interval ______ sec.
Vent. rate *35* /min QRS duration *0.08* sec. Dev. Elect. Axis *Left*

Deviation from Normal

I		V1	*R' present*
II		V2	
III		V3	
VR	*R prominent*	V4	
VL		V5	
VF		V6	

Interpretation *Normal sinus rhythm with 2 : 1 A-V block. Left axis deviation.*

Every other atrial beat is followed by ventricular response. The presence of R' in V1 suggests incomplete right bundle branch block.



Complete A V Block with His Bundle Rhythm

ATRIOVENTRICULAR BLOCK, COMPLETE, WITH HIS BUNDLE RHYTHM

REPORT OF ELECTROCARDIOGRAM

EKG No. *11*

Name ________ Age *55* Date & Time ________ Chart No. ________

Blood Pressure *130/80* Habitus ________ Position *Supine* Drugs *None*

Atrial rate *88* /min. P-R interval ____ sec Q-T interval ____ sec
Vent. rate *45* /min. QRS duration *0.07* sec. Dev. Elect. Axis *None*

Deviation from Normal

I	*T inverted*	V1	
II	*T inverted*	V2	
III	*T inverted*	V3	
VR	*T upright*	V4	
VL		V5	*T inverted*
VF		V6	
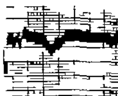
Interpretation *Normal sinus rhythm with complete A V block and idioventricular His bundle rhythm. No axis deviation.*

The atrial beats bear no relation to an autonomous pacemaker arising somewhere in the His bundle just below the A V node.





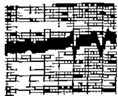


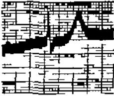












Complete A V Block with Idioventricular Rhythm

ATRIOVENTRICULAR BLOCK COMPLETE WITH IDIOVENTRICULAR RHYTHM

REPORT OF ELECTROCARDIOGRAM

EKG No. 11

Name ________ Age __ Date & Time ____ Chart No. ____

Blood Pressure 1?/7? Habit ____ Duration 5 min Drugs None

Atrial rate 80 /min. P-R interval ____ sec Q-T interval ____ sec

Vent. rate 43 /min QRS duration .11 sec Dev. Elect. Axis ____

Deviation from Normal		
	I ________	V1 ________
	II ________	V2 ________
	III ________	V3 ________
	aVR ________	V4 ________
	aVL ________	V5 ________
	VF ________	V6 ________

Interpretation *Normal sinus rhythm with complete A-V block and idioventricular rhythm*

The atria are beating at a faster rate than, and are wholly independent of, a much slower autonomous pacemaker arising in the ventricular myocardium.

























Left Bundle Branch Block

REPORT OF ELECTROCARDIOGRAM

EKG No. 13

Name ______ Age 33 Date & Time ______ Chart No. ______

Blood Pressure 132/70 Habitus ______ Position Supine Drugs None

Atrial rate 72 /min. P R interval 0.17 sec. Q T Interval ______ sec.
Vent. rate [illegible] /min. QRS duration 0.16 sec. Dev. Elect. Axis None

Deviation from Normal

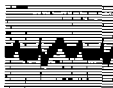
Lead	Finding	Lead	Finding
I	*R slurred, ST depressed, T diphasic*	V1	*S slurred*
II	*R slurred, ST depressed, T diphasic*	V2	
III	*R slurred, T inverted*	V3	
VR	*ST elevated, T upright*	V4	
VL		V5	*R' present, ST depressed, T diphasic*
aVF	*R slurred, ST depressed, T inverted*	V6	*R' present, ST depressed, T inverted*

Interpretation *Normal sinus rhythm. No axis deviation. Left bundle branch block.*

The delayed R' over the left ventricle (the onset of the intrinsicoid deflection equals 0.13 second) confirms left bundle branch block. Abnormalities of ST and T waves are usually seen in left bundle branch block.

The "intrinsicoid deflection" determined in a precordial lead measures the time it takes for a stimulus to reach a point directly beneath the precordial electrode. In this instance the time from onset of Q to the peak of R


I

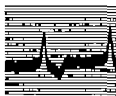

II

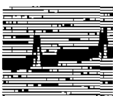

III


aVR

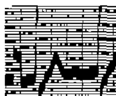

aVL

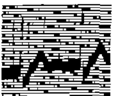

aVF


V1


V2


V3


V4


V5


V6

Right Bundle Branch Block and Long P R Interval

RIGHT BUNDLE BRANCH BLOCK, INCOMPLETE ATRIOVENTRICULAR BLOCK

REPORT OF ELECTROCARDIOGRAM

ECG No. 11

Name ________ Age 11 Date ________ Chart No. ________

Blood Pressure 103/70 Habitus ________ min. Drugs None

Atrial rate 75 /min. P R interval 0.23 sec. Q T interval ________ sec.
Vent. rate 75 /min. QRS duration 0.13 sec. Dev. Elect. Axis Left

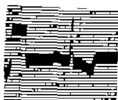
Deviation from Normal:

I S wide	V1 R' present
II	V2 R' present
III	V3
VR	V4 S wide
VL T low	V5 S wide
VF	V6 S wide

Interpretation: *Normal sinus rhythm. Left axis deviation. Incomplete A-V block (prolonged P-R interval). Right bundle branch block.*

The delayed R' over the right ventricle (the onset of the intrinsicoid deflection equals 0.08 second) confirms right bundle branch block.


I

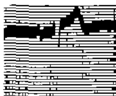

II

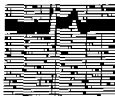

III


aVR


aVL

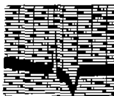

aVF

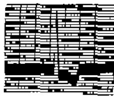

V1


V2


V3


V4


V5


V6

Left Ventricular Hypertrophy

REPORT OF

EKG No. *13*

Name ______________ Age

Chart No. ______

Blood Pressure *230/110* Habitus

Drugs *None*

Atrial rate *60* /min. P R interval *0.[illegible]0* sec Q T interval __________ sec

Vent. rate *60* /min. QRS duration *0.[illegible]* sec Dev. Elect. Axis *Left*

Deviation from Normal

Lead		Lead	
I	*ST depressed, T inverted*	V1	*S deep, ST elevated*
II	*ST depressed, T inverted*	V2	
III	*T inverted*	V3	*ST depressed, T inverted*
VR	*T upright*	V4	*ST depressed, T inverted*
VL	*T diphasic*	V5	*R delayed*
VF	*T inverted*	V6	*R delayed*

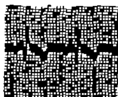
Interpretation *Normal sinus rhythm. Left axis deviation.*

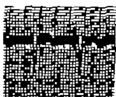
The left ventricular activation is delayed (the onset of the intrinsicoid deflection equals 0.05 second) and with a normal QRS interval suggests a thickened left ventricular myocardium. Deviation of ST and T waves are often seen in the presence of this hypertrophy.


I

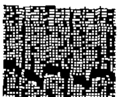

II

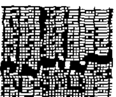

III

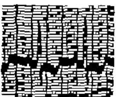

aVR

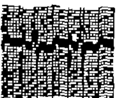

aVL


aVF

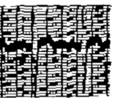

V1


V2


V3


V4


V5


V6

Right Ventricular Hypertrophy

REPORT OF ELECTROCARDIOGRAM

EKG No. *18*

Name ______ Age *30* Date & Time ______ Chart No. ______

Blood Pressure *100/76* Habitus ______ Posture *Supine* Drugs *None*

Atrial rate *88* /min. P-R interval *0.1* sec Q-T interval ______ sec
Vent. rate *88* /min. QRS duration *0.09* sec Dev. Elect. Axis *Right*

Deviation from Normal

I	*S deep*	V1	*R late and large*
II		V2	*ST depressed, T inverted*
III		V3	*ST depressed, T inverted*
VR		V4	*ST depressed, T diphasic*
VL		V5	*S deep, T inverted*
VF		V6	*S deep*

Interpretation *Normal sinus rhythm. Right axis deviation.*

The late R wave over the right ventricle (the onset of the intrinsicoid deflection equal 0.06 second), persistence of large S over the left ventricle, and the ST and T wave changes are characteristic of right ventricular hypertrophy.

In this instance the time from onset of Q to the peak of R in precordial lead.





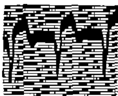






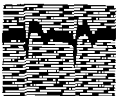


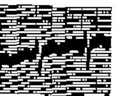












Recent Anterior Myocardial Infarction

RECENT ANTERIOR MYOCARDIAL INFARCTION

REPORT OF ELECTROCARDIOGRAM

EKG No. *17*

Name ______ Age *60* Date ______ Chart No. ______

Blood Pressure *90/60* Habitus ______ Position *Supine* Drugs *None*

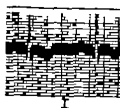
Atrial rate *90* /min. P-R interval *0.20* sec. Q-T interval ______ sec.
Vent. rate *90* /min. QRS duration *0.08* sec. Dev. Elect. Axis *Left*

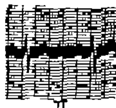
Deviation from Normal

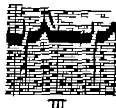
Lead	Deviation	Lead	Deviation
I	*T inverted*	V1	*Absent R, ST elevated*
II	*ST depressed*	V2	*Absent R, ST elevated, T diphasic*
III	*ST depressed*	V3	*Absent R, ST elevated, T diphasic*
VR		V4	*R low, ST elevated, T inverted*
VL	*ST elevated, T inverted*	V5	*R low, ST elevated, T inverted*
VF	*ST depressed*	V6	*R low, T diphasic*

Interpretation *Normal sinus rhythm. Left axis deviation.*

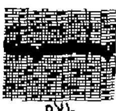
The low or absent R waves in V leads, together with the other reciprocal ST and T wave changes, are characteristic of recent anterior wall infarction.

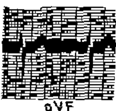


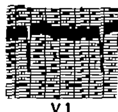


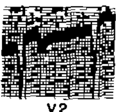


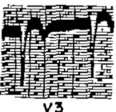


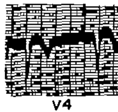


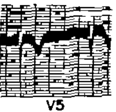


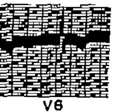












Old Anterior Myocardial Infarction

REPORT OF [illegible]

EKG No. 18

Name ______ Age 60 Date & Time ______ Chart No. ______

Blood Pressure 110/60 Habitus ______ Position Supine Drugs Digitalis 0.1 mg d

Atrial rate 64 /min. P R interval 0.22 sec Q T interval ______ sec.
Vent. rate 64 /min. QRS duration 0.09 sec Dev. Elect. Axis Left

Deviation from Normal

Lead		Lead	
I	T inverted	V1	Absent R
II		V2	Absent R T diphasic
III	S deep	V3	R low T diphasic
VR	T low	V4	Absent R, T inverted
aVL	T inverted	V5	R low T inverted
aVF		V6	T inverted

Interpretation *Normal sinus rhythm. Left axis deviation. Incomplete AV block (prolonged PR interval)*

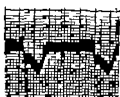
When compared with the patient's previous tracing (page [illegible])*, changes are seen suggesting evolution of the anterior wall infarct. Deviation in ST segments has vanished and the T waves have become more inverted and have assumed a coved appearance. The prolonged PR interval may be the result of digitalis administration.*

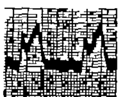




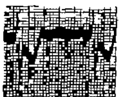


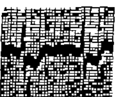




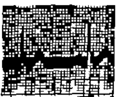


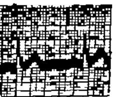












Recent Posterior Myocardial Infraction

REPORT OF ELECTROCARDIOGRAM

EKG No. _19_

Name ________ Age _46_ Date & Time ________ Chart No. ________

Blood Pressure _100/68_ Habitus ________ Position _Supine_ Drugs _None_

Atrial rate _78_ /min. P R interval _0.16_ sec Q-T interval ________ sec
Vent. rate _72_ /min. QRS duration _0.07_ sec Dev. Elect. Axis _None_

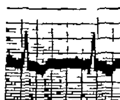
Deviation from Normal

I	_T low_	V1	_ST depressed_
II	_ST elevated_	V2	_ST depressed_
III	_ST elevated_	V3	_ST depressed_
VR	_ST depressed_	V4	_ST depressed_
VL	_ST depressed_	V5	
VF	_ST elevated_	V6	

Interpretation _Normal sinus rhythm. No axis deviation_

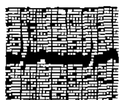
The elevated ST segments in leads II, III and AVF and reciprocal ST depressions in other leads are characteristic of recent posterior wall infarct.

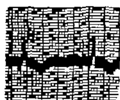

I

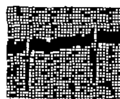

II

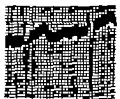

III

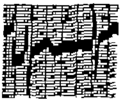

aVR

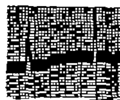

aVL

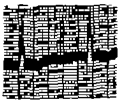

aVF

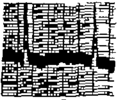

V1


V2


V3


V4


V5


V6

Old Posterior Myocardial Infarction

REPORT OF ELECTROCARDIOGRAM

EKG No. *20*

Name ______ Age *46* Date & Time ______ Chart No. ______

Blood Pressure *130/70* Habit ______ Position *Supine* Drugs *None*

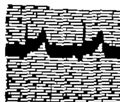
Atrial rate *65* /min P R interval *0.21* sec Q-T interval ______ sec
Vent. rate *65* /min. QRS duration *0.08* sec Dev. Elect. Axis *None*

Deviation from Normal:

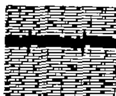
I ______	V1 ______
II *T inverted*	V2 ______
III *Q wide, T inverted*	V3 ______
VR *T upright*	V4 *T low*
VL ______	V5 *T inverted*
VF *Q wide, T inverted*	V6 *T inverted*

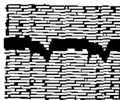
Interpretation *Normal sinus rhythm. No axis deviation. Incomplete AV block (prolonged PR interval).*

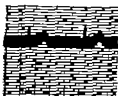
The wide Q waves in III and VF as well as T wave inversions are suggestive of posterior wall infarct, probably old, with some lateral wall damage as well.


I


II


III


aVR


aVL


aVF


V1


V3


V5

Pericarditis—acute

REPORT OF ELECTROCARDIOGRAM

EKG No. 81

Name ______ Age 59 Date & Time ______ Chart No. ______

Blood Pressure 180/70 Habitus ______ Position Supine Drugs None

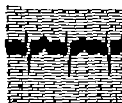
Atrial rate 78 /min P R interval 0.19 sec Q T interval ______ sec.
Vent. rate 8 /min. QRS duration 0.06 sec Dev. Elect. Axis None

Deviation from Normal:

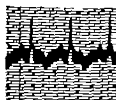
Lead		Lead	
I	ST elevated	V1	
II	ST elevated	V2	
III	ST elevated	V3	
VR	ST depressed	V4	
VL		V5	
VF	ST elevated	V6	

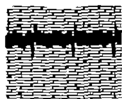
Interpretation: Normal sinus rhythm. No axis deviation.

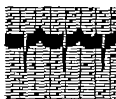
The elevated ST segments in all three standard leads, without QRS changes, are consistent with acute pericarditis.

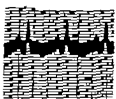


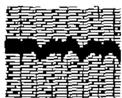


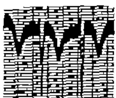


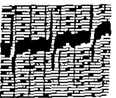












Pulmonary Embolism

REPORT OF ELECTROCARDIOGRAM

EKG N _12_

ame ________ Age _45_ Date & Time ________ Chart N ________

Blood Pressure _100/65_ Habitus ________ Position _Supine_ Drugs _Vone_

Atrial rate _125_ /min. P R interval _0.16_ sec. Q T interval ________ sec.

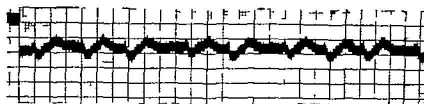
Vent. rate _125_ /min. QRS duration _0.06_ sec. Dev Elect. Axis _Right_

Deviation from Normal

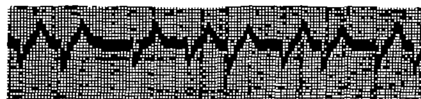
Lead	Finding	Lead	Finding
I	*S deep*	V1	*ST elevated*
II	*T diphasic*	V2	
III	*T inverted*	V3	*T inverted*
VR	*R' present*	V4	
VL		V5	
VF	*T inverted*	V6	

Interpretation *Sinus tachycardia. Right axis deviation*

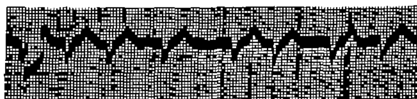
Since previous tracing taken on this patient 8 hours ago there has been significant increase in ventricular rate. In addition, right axis deviation with an upright QRS in lead III and largely downward QRS in lead I has appeared. T2 which was previously upright, has become diphasic, and T3 has become inverted as well as T AVF. An R' has appeared in lead AVR, and the ST segment in lead V1 is slightly elevated. These changes are suggestive of acute right heart strain of the type often seen with recent pulmonary embolism. The diagnosis of this condition is dependent upon the demonstration of serial changes of an transient nature.



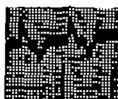
I



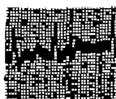
II



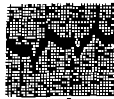
III



V1



V3



V5

Hyperkalemia—K, 8 6 mEq/L; Na 113 mEq/L

REPORT OF ELECTROCARDIOGRAM

EKG No. *83*

Name ________ Age *58* Date & Time ________ Chart No. ________

Blood Pressure *110/60* Habitus ________ Position *8 p.m.* Drugs *None*

Atrial rate ____ /min. P-R interval ____ sec Q-T interval ____ sec
Vent. rate *80* /min. QRS duration *0.14* sec Dev. Elect. Axis ____

Deviation from Normal

I		V1	
II		V2	
III		V3	
aVR		V4	
aVL		V5	
aVF		V6	

Interpretation *Idioventricular rhythm*

Since the previous record (not illustrated), the patient has developed marked widening of the QRS complex as well as complete AV dissociation. A idioventricular pacemaker is seen [illegible]. The rhythm is grossly irregular. The abnormalities are consistent with marked derangement of cardiac metabolism.

Hemodynamics

SECTION 3

Representative NORMAL VALUES

Blood and Blood Gases

Arterial blood O_2 content = 16.5–20 ml/100 ml of blood

Arterial or venous blood oxygen capacity = 17–21 ml/100 ml of blood

Arterial blood O_2 saturation = $\frac{O_2 \text{ content}}{O_2 \text{ capacity}} \times 100$ = 96–98%

Arterial blood CO_2 content (whole blood) = 40–55 ml/100 ml = 18–25 mEq./liter

pH arterial plasma = 7.39–7.41

Arterial blood and alveolar CO_2 tension = P_{CO_2} = 39–41 mm. Hg

Mixed venous blood O_2 content = 12–16 ml./100 ml.

CO_2 combining power (venous blood) = 50–70 ml/100 ml = 21–30 mEq./liter

Hematocrit = per cent red blood cells in blood = 38–48

Hemoglobin = 13–16 gm/100 ml of blood

Blood oxygen capacity ml/100 ml of blood × 0.746 = hemoglobin gm/100 ml. The factor 0.746 is derived from the fact that 1 gm. of hemoglobin combines with 1.34 ml of oxygen

(ml./100 ml. of blood = vols % in older terminology)

Continued on next page

NORMAL VALUES continued

Cardiocirculatory

Blood Volume

Total blood volume average = 2500 cc /sq m B S A *
Plasma volume average = 1500 cc /sq m B S A
Red cell volume average = 1000 cc sq m B S A

Cardiac Output normal range = 4 0–6 5 lit /min

Cardiac Index normal range = 2 7–3 5 lit /min sq m B S A

Blood Pressures representative

	SYSTOLIC mm Hg	DIASTOLIC mm. Hg	MEAN mm Hg	MEAN cm. H_2O
Brachial vein	—	—	1	3 7
Right atrium	—	—	0	0 5
Right ventricle	22	0	—	
Pulmonary artery	22	8	13	
Left atrium	—	—	7	
Left ventricle	120	5	—	
Brachial artery	120	80	95	

BODY SURFACE AREA (B S A.) ACCORDING TO DU BOIS FORMULA
B S A. in square meters = (weight in kg.)$^{[illegible]}$ × (height in cm.)$^{[illegible]}$ × 0 007184

Sample values

HEIGHT F in	HEIGHT cm.	WEIGHT lbs.	WEIGHT Kg	B.S.A. square meters
4 10	14	90	41	1 25
5 8	173	140	63	1 73
6' 2	188	210	91	2 20

NORMAL VALUES continued

Pulmonary

Vital Capacity liters Male = 2.5 × sq m B.S.A.
Female = 2.0 × sq.m B.S.A.

Tidal Air liters 0.350 to 0.600

Residual Volume (air in lungs at maximal expiration) liters 1.0 to 1.5

Total Lung Capacity = Vital Capacity + Residual Volume liters 5.0 to 7.5

Residual Volume/Total Capacity = 20 to 30%

Maximum Breathing Capacity † Male = 100–150 lit min
Female = 70–120 lit min

Respiratory Rate at rest 8–20 min

Pulmonary Ventilation at rest 2.5–4.0 lit min sq m B.S.A.

Oxygen Uptake at rest 110–140 cc min sq m B.S.A.

CO Output at rest 88–120 cc min sq m B.S.A.

Respiratory Exchange Ratio (Resp Quotient R.Q.) 0.77–0.90

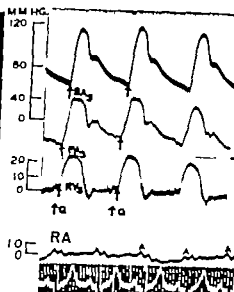
Bronchospirometry function in right lung 52–58 per cent left lung 48–42 per cent

Timed Vital Capacity first second 75% or more of total vital capacity first 2 seconds 90% or more first 3 seconds 100%

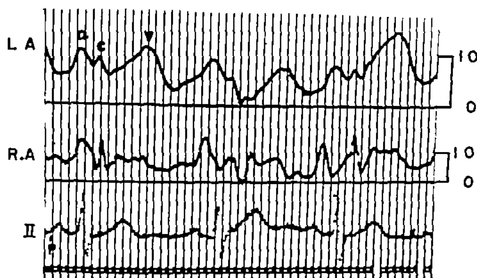
More accurate formulas
Males Vit. cap., liters = [27.63 − (0.112 × age in yr.)] × Ht. in cm.
Females Vit. cap. liters = [21.78 − (0.101 × age in yr.)] × Ht. in cm.

† Formulas
Males M.B.C. lit./min. = [86.5 − (0.522 × age in yr.)] × sq m B.S.A.
Females M.B.C. lit./min. = [71.3 − (0.474 × age in yr.)] × sq m B.S.A.


A



B



C

FIGURE 15—AT LEFT

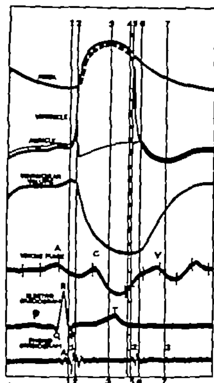
A. X Ray showing a cardiac catheter introduced via the right brachial vein into the right pulmonary artery

B The relation between electrical and mechanical events on the right side of the heart The electrical event is indicated by lead 2 of the electrocardiogram the mechanical event is indicated by the pressure pulse in the right atrium right ventricle pulmonary artery and brachial artery respectively The pressures in the right atrium ventricle and pulmonary artery were recorded through a cardiac catheter

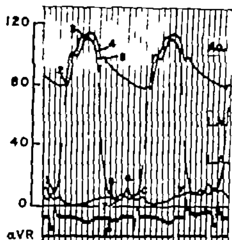
- P — Electrical event preceding atrial contraction
- A — Atrial systole
- Q — Electrical event preceding ventricular contraction
- RV — Start of isometric contraction of right ventricle
- PA_1 — Start of ejection of blood into pulmonary artery
- BA_1 — Start of ejection of blood into aorta as manifested in the brachial artery pressure pulse

C Simultaneous pressure pulses in the right and left atria recorded by direct needle puncture during thoracic surgery The configuration of the two curves is similar differing primarily in the greater height of the V wave in the left atrial pressure pulse a reflection of the lesser distensibility of the left atrial pulmonary venous system

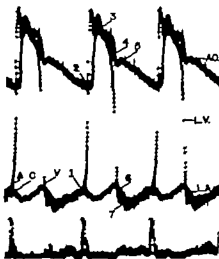
NOTES


A
C
V
P
R
T
Q
A
1 2
3
4 5 6
7

A


120
80
40
0
aVR

B


3
4
5
A.O.
L.V.
A
C
V
1
6
7

C


3
4
5
A.O.
L.V.
C
A
V
X

D

FIGURE 14—AT LEFT

A. Schema based on observations in man and dog

1 Closure of A V valves
2 Opening of aortic valve
1–2 Isometric contraction
2–3 Maximal ejection.
3–4 Reduced ejection
4–5 Protodiastole
5 Closure of aortic valve
5–6 Isometric relaxation
6 Opening of A V valves
6–7 Rapid filling of ventricle
7 to atrial systole Diastasis.

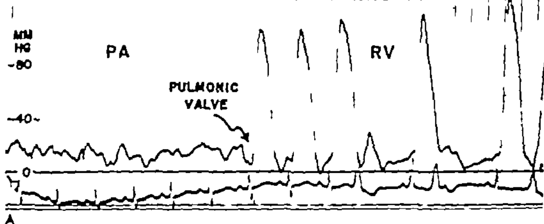
Time line on venous pulse at 0 10 second

B Pressure pulses from the left side of the heart obtained during intra thoracic surgery by direct needling of the aorta (AO) left ventricle (LV) and left atrium (LA) in a subject without cardiovascular disease Numbers 1–7 as above Time between two vertical lines i 0.04 second.

C Pressure pulses in another normal subject without cardiovascular disease for comparison with (D)

D Pressure pulses from the left side of the heart recorded prior to ther apeutic fracture of the mitral valve in a patient with mitral stenosis Sym bols and numbers as above Note in contrast to the normal pressure pulses, the pressure gradient between the left atrium and ventricle during diastole

NOTES



COARCTATION OF AORTA

BRACHIAL ARTERY
216/100
M.P 138
Q→B.A. 0.14

MM HG
FA
BA

FEMORAL ARTERY
114/84
M.P 98
Q→F.A. 0.20

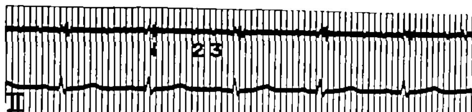
B

FIGURE 17—AT LEFT

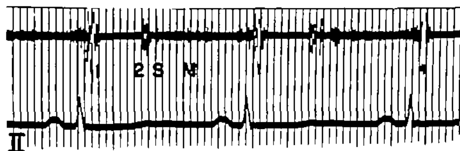
A. *Pulmonic valvular stenosis* A continuous tracing as the cardiac catheter is withdrawn from the pulmonary artery (PA) through the pulmonic valve into the right ventricle (RV) The pulmonary artery pressure is typically low and distorted by artefacts The right ventricular systolic pressure is considerably elevated The fourth ventricular beat is premature and clearly depicted in the electrocardiogram (lead 2)

B *Coarctation of aorta* The brachial artery (BA) pressure is greater than normal The femoral artery pressure curve (FA) is deformed and has a lower systolic pressure than in the brachial artery

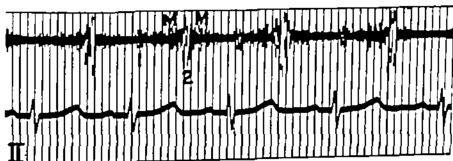
NOTES



A. NORMAL CHILD



B. MITRAL STENOSIS



C. PATENT DUCTUS ARTERIOSUS

PHONOCARDIOGRAPHY

FIGURE 18—AT LEFT

A *Normal child* Illustrating first (1) second (2) and physiologic third (3) heart sounds

B *Pure' mitral stenosis* There is no systolic murmur (between 1 and 2) The opening snap of the mitral valve (S) is followed by a diastolic murmur with presystolic accentuation

C *Patent ductus arteriosus* The continuous machinery murmur (M) is illustrated in relation to the normal heart sounds (1 and 2)

NOTES

SECTION 4

A complete diagnosis should include the following five considerations

1 *Etiology* of the heart disease and whether active or inactive

2 *Structural changes*

3 *Cardiac mechanism and disturbed cardiac physiology*

4 *Cardiac functional capacity*

5 *Therapeutic classification*

An example of a complete cardiac diagnosis is

1 Rheumatic heart disease inactive

2 Mitral stenosis and insufficiency tricuspid stenosis Enlarged heart (dilated left and right atria and right ventricle)

3 Atrial fibrillation persistent Congestive heart failure paroxysmal pulmonary edema

4 5 Class IIID

The descriptive material pertinent to the first three headings too long for inclusion in this Notebook it is detailed in the Nomenclature and Criteria for Diagnosis of Diseases of the Heart published by the New York Heart Association Headings 4 and 5 cardiac functional capacity and therapeutic classification, are itemized on the next page

CARDIAC FUNCTIONAL CAPACITY

Class I Patients with cardiac disease but *without resulting limitation of physical activity*. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain.

Class II Patients with cardiac disease resulting in *slight limitation of physical activity*. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain.

Class III Patients with cardiac disease resulting in *marked limitation of physical activity*. They are comfortable at rest. Less than ordinary physical activity causes fatigue, palpitation, dyspnea, or anginal pain.

Class IV Patients with cardiac disease resulting in *inability to carry on any physical activity without discomfort*. Symptoms of cardiac insufficiency or of the anginal syndrome are present even at rest. If any physical activity is undertaken, discomfort is increased.

THERAPEUTIC CLASSIFICATION

Class A Patients with cardiac disease whose ordinary physical activity need not be restricted.

Class B Patients with cardiac disease whose ordinary physical activity need not be restricted but who should be advised against severe or competitive physical efforts.

Class C Patients with cardiac disease whose ordinary physical activity should be moderately restricted and whose more strenuous efforts should be discontinued.

Class D Patients with cardiac disease whose ordinary physical activity should be markedly restricted.

Class F Patients with cardiac disease who should be at complete bed rest, confined to bed or chair.

NO HEART DISEASE

(a) Predisposing etiological factor, e.g. rheumatic fever.

(b) Undiagnosed manifestation, e.g. pulmonic systolic murmur.

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